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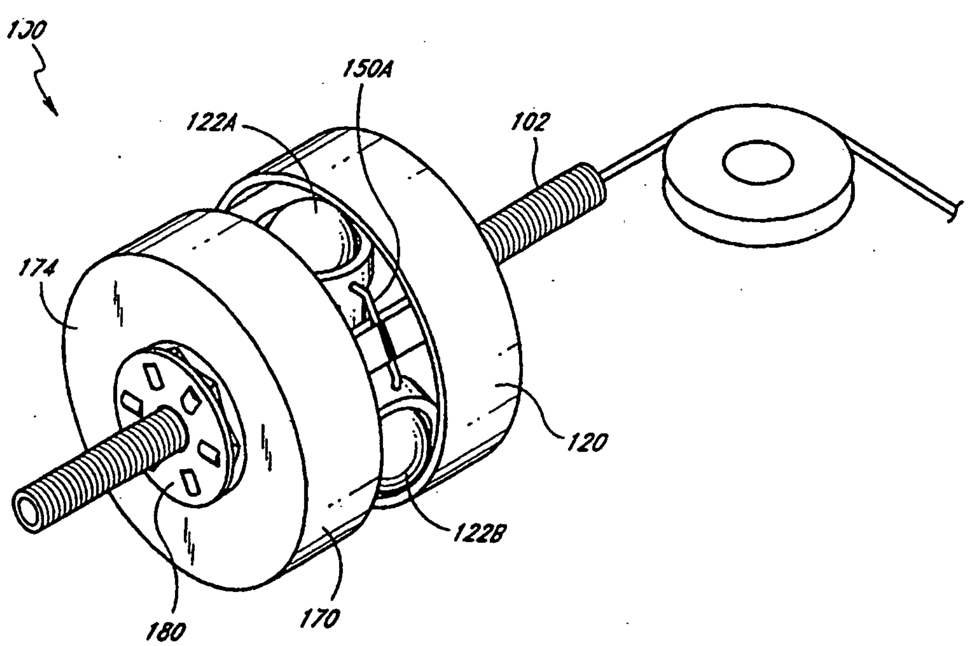

(57) Abstract

A continuously variable transmission (100) having a plurality of rotatable power adjusters (122) for transmitting power from a driving member (120) to a driven member (170). Each power adjuster (122) is frictionally interposed between the driving member (120), the driven member (170), and a rotatable support (154), so that the power adjusters (122) each make three point frictional ...

CONTINUOUSLY VARIABLE TRANSMISSION

Background of the Invention

Field of the Invention

The field of the invention relates to transmissions. More particularly the invention relates to continuously variable transmissions.

Description of the Related Art

In order to provide an infinitely variable transmission, various traction roller transmissions in which power is transmitted through traction rollers supported in a housing between torque input and output disks have been developed. In such transmissions, the traction rollers are mounted on support structures which, when pivoted, cause the engagement of traction rollers with the torque disks in circles of varying diameters depending on the desired transmission ratio.

However, the success of these traditional solutions have been limited. For example, in U.S. Patent No. 5,236,403 to Schievelbusch, a driving hub for a vehicle with a variable adjustable transmission ratio is disclosed. Schievelbusch teaches the use of two iris plates, one on each side of the traction rollers, to tilt the axis of rotation of each of the rollers. However, the use of iris plates can be very complicated due to the large number of parts which are required to adjust the iris plates during shifting the transmission. Another limitation of this design is that it requires the use of two half axles, one on each side of the rollers, to provide a gap in the middle of the two half axles. The gap is necessary because the rollers are shifted with rotating motion instead of sliding linear motion. The use of two axles is not desirable and requires a complex fastening system to prevent the axles from bending when the transmission is accidentally bumped, is as often the case when a transmission is employed in a vehicle. Yet another limitation of this design is that it does not provide for an automatic transmission.

Figure 2 is a partial exploded view of the transmission of Figure 1.

Figure 3 is an end cutaway elevational view of the transmission of Figure 1.

Figure 4 is a cutaway side elevational view of the transmission of Figure 1.

Figures 5 and 6 are cutaway side elevational views of the transmission of Figure 1 illustrating the transmission of Figure 1 shifted into different positions.

Figure 7 is an end cutaway view of an alternative embodiment of the transmission of the invention wherein the transmission shifts automatically.

Figure 8 is a side elevational view of the transmission of Figure 7.

Figure 9 is an end cutaway view of an alternative embodiment of the transmission of the invention wherein the transmission includes a stationary hub shell.

Figure 10 is a cutaway side elevational view of the transmission of Figure 9.

Figure 11 is a cutaway side elevational view of an alternative embodiment of the transmission of Figure 1 wherein the transmission has two thrust bearings.

Figure 12 is a cutaway side elevational view of an alternative embodiment of the invention wherein a first and second one way rotatable driver provides an input torque to the transmission.

Figure 13 is a schematic cutaway end elevational view of another alternative embodiment of the transmission of the invention.

Figure 14 is a schematic cutaway front elevational view of the transmission of Figure 13.

Figure 15 is a schematic end view of a housing for the transmission of Figures 13 and 14.

Figure 16 is a schematic cutaway front elevational view of another alternative embodiment of the transmission of the invention.

Figure 17 is a side elevational view of an alternative embodiment of a support member.

Figure 18 is a side elevational view of an alternative embodiment of a support member.

Figure 19 is a side elevational view of an alternative embodiment of a support member.

Figure 20 is a schematic cutaway side elevational view of an alternative embodiment of the invention including: a thrust bearing, a washer, and a tension member.

Figure 21 is a schematic cutaway side elevational view of an alternative embodiment of the invention wherein the support member has at each end a thrust bearing

The present invention includes a continuously variable transmission that may be employed in connection with any type of machine that is in need of a transmission. For example, the transmission may be used in (i) a motorized vehicle such as an automobile, motorcycle, or watercraft, (ii) a non-motorized vehicle such as a bicycle, tricycle, scooter, exercise equipment or (iii) industrial power equipment, such as a drill press or power generating equipment, such as a windmill.

Figures 1 through 4 disclose one embodiment of the present invention. Figure 1 is a partial perspective view of a transmission 100. Figure 2 is an exploded view of the transmission 100 of Figure 1. Figure 3 shows a partial cross sectional end view of the transmission 100. Figure 4 shows a cutaway side elevational view of the transmission 100.

Referring generally to Figures 1 through 4, a hollow main shaft 102 is affixed to a frame of a machine (not shown). The shaft 102 may be threaded at each end to allow a fastener (not shown) to be used to secure the transmission 100 on the main shaft 102 and/or to attach the main shaft 102 to a machine. A rotatable driver 401 (Figure 4) comprising a sprocket or a pulley is rotatably affixed to the main shaft 102, so as to provide an input torque to the transmission 100. A drive sleeve 104 is coaxially coupled to the rotatable driver 401 (Figure 4) and rotatably disposed over the main shaft 102. A surface 106 (Figure 2) of the drive sleeve 104 opposite the rotatable driver 401 (Figure 4), can include a plurality of shallow grooves 108.

A first roller cage assembly 110 is coaxially coupled to the drive sleeve 106 opposite the rotatable driver 401 and also rotatably disposed over the main shaft 102. The first roller cage assembly 110 has a plurality of cylindrical rollers 112 radially arranged about a midpoint of the roller cage assembly 110. Each of the cylindrical rollers 112 are rotatably mounted on the first roller cage assembly 110 such that each of the rollers may rotate about its lengthwise axis. Preferably, a one-to-one correlation exists between each of the shallow grooves 108 and each of the cylindrical rollers 112. Optionally, the cylindrical rollers 112 may be replaced with rollers of an alternative geometric shape, such as with spherical rollers.

A tension inducer 118 (Figure 2), such as a spring, is rotatably disposed over the main shaft 102 and frictionally coaxially coupled to the first roller cage assembly 110 opposite to the drive sleeve 104. Further, a rotatable driving member 120 is rotatably affixed to the main shaft 102 and coaxially coupled to a side of the first roller cage assembly 110 opposite the drive sleeve 104. A surface 107 (Figure 4) of the rotatable driving

(Figure 2). The stationary support 152 is fixedly attached to the main shaft 102.

A support member 154 is slidingly and rotatably disposed over the main shaft 102 proximate to a side of the stationary support 152 (Figure 2) which is opposite to the rotatable driving member 120. The support member 154 is in frictional contact with each of the power adjusters 122A, 122B, 122C. In one embodiment of the invention, the support member 154 is a cylindrical ring having a substantially uniform outer circumference from an end cross-sectional view. In another embodiment of the invention, the support member 154 is a cylindrical ring having a first and second flange (not shown) which respectively extend radially outwardly from a first and second end of the support member 154 so as to prevent the power adjusters 122A, 122B, 122C from disengaging from the support member 154. In yet another embodiment of the invention, the support member 154 is a cylindrical ring having a nominally concave outer surface (Figure 17).

The support member 154 may contact and rotate upon the main shaft 102, or may be suspended over the main shaft 102 without substantially contacting it due to the centering pressures applied by the power adjusters 122A, 122B, 122C.

Referring in particular to Figure 2, a shifting member 160, such as an inflexible rod, is slidingly engaged to an inner passage of the main shaft 102. Two extensions 162, 164 perpendicularly extend from the shifting member 160 through an opening 165 in the main shaft 102. A first end 161 of the shifting member 160 proximate to the drive side of the transmission 100 is connected to a linkage 163, such as a cable. The linkage 163 is connected at an end opposite to the main shaft 102 to a shifting actuator (not shown). A tension member 202, such as a spring, is connected to a second end of the shifting member 160 by a fastener 204.

Still referring in particular to Figure 2, the extensions 162, 164 connect to the ratio changer 166. The ratio changer 166 includes a planar platform 168 and a plurality of legs 171A, 171B, 171C which perpendicularly extend from a surface of the platform 168 proximate to the support member 154. The leg 171A includes two linkage pins 172A, 173A. Similarly, the leg 171B includes two linkage pins 172B and 173B, and the leg 171C includes two linkage pins 172C and 173C. The linkage pins 172A, 172B, 172C, and the linkage pins 173A, 173B, 173C are used to couple the ratio changer 166 to each of the pivot supports 134A, 134B, and 134C.

In regard to the coupling of the support 134A and the ratio changer 166, the linkage pin 172A engages an end of the leg 137A of the support 134A opposite the pivot ring 136A, and the linkage pin 172B engages an end of the leg 135A opposite the pivot

means. The hub shell 302 is supported and is free to rotate on the main shaft 102 by means of hub bearings 410 (Figure 4) which fit into slots in the hub driver 186. A washer 412 (Figure 4) is affixed to the main shaft 102 proximate to a side of the hub driver 186 opposite the second roller cage assembly 180 to facilitate the rotation of the hub bearings 410 (Figure 4).

Figures 5 and 6 are a cutaway side elevational views of the transmission of Figure 1 illustrating the transmission of Figure 1 in two different shifted positions. With reference to Figures 5 and 6, a method of shifting the transmission 100 is disclosed below.

Upon an input force, the drive sleeve 104 begins to rotate in a clockwise direction. (It should be noted that the transmission 100 is also designed to be driven in a counter-clockwise direction.) At the beginning of the rotation of the drive sleeve 104, nominal axial pressure is supplied by the tension inducers 118, 178 (Figure 2) to ensure that the rotatable driving member 120, the rotatable driven member 170, and the support member 154 are in tractive contact with the power adjusters 122A, 122B, 122C.

The rotation of the drive sleeve 104 in a clockwise direction engages the first roller cage assembly 110 to rotate in a similar direction. At a low torque, the rollers 112 remain centered between the shallow grooves 108, 109 of the rotatable driving member 120 and the drive sleeve 104. As additional torque is applied, the rollers 112 ride up the sloping sides of the grooves 108 and force the drive sleeve 104 and the rotatable driving member 120 farther apart. The same action occurs on the opposite end of the transmission 100 wherein the rotatable driven member 170 engages the hub driver 186 though the second roller cage assembly 180. Thus, the first roller cage assembly 110 and second roller cage assembly 180 compress the rotatable driving member 120 and the rotatable driven member 170 together against the power adjusters 122A, 122B, 122C, which increases the frictional contact of the power adjusters 122A, 122B, 122C against the support member 154, the drive member 120, and the driven member 170.

As the first rotatable driving member 120 is rotated in a clockwise direction by the roller cage assembly 110, the first rotatable driving member 120 frictionally rotates the power adjusters 122A, 122B, 122C. The clockwise rotation of the power adjusters 122A, 122B, 122C causes a clockwise rotation of the rotatable driven member 170. The clockwise rotation of the rotatable driven member 170 engages the second roller cage assembly 180 to rotate in a clockwise direction. In turn, the clockwise rotation of the second roller cage assembly 180 engages the hub driver 186 (Figure 4) to drive in a

decreases an output angular velocity for the transmission 100 because for every revolution of the rotatable driving member 120, the rotatable driven member 170 rotates less than once.

Figures 7 and 8 illustrate an automatic transmission 700 of the present invention. For purposes of simplicity of description, only the differences between the transmission 100 of Figures 1-6 and the automatic transmission 700 are described. Figure 7 is a partial end elevational view of the transmission 700, and Figure 8 is partial side elevational view of the transmission 700.

A plurality of tension members 702A, 702B, 702C, which may each be a spring, interconnect each of the pivot rings 136A, 136B, 136C. The tension member 702A is connected at a first end to the pivot ring 136A and at a second end opposite the first end to the pivot ring 136B. Further, the tension member 702B is connected at a first end to the pivot ring 136B proximate to the aperture 138B and at a second end opposite the first end to the pivot ring 136C proximate to the aperture 138C. Further, the tension member 702C is connected at a first end to the pivot ring 136C proximate to the aperture 138C and at a second end opposite the first end to the pivot ring 136A proximate to the aperture 138A.

The transmission 700 also includes flexible extension members 708A, 708B, 708C respectively connected at a first end to the pivot rings 136A, 136B, 136C. The transmission 700 also includes a first annular bearing 806 and a second annular bearing 816 to assist in the shifting of the transmission 700. The first annular bearing 806 is slidingly attached to the hub shell 302 such that first the annular bearing 806 can further be directed toward the rotatable driving member 120 or the rotatable driven member 170. The second annular bearing 816 also is configured to be slid toward either the rotatable driving member 120 or the rotatable driven member 170; however, the second annular bearing 816 is not rotatable about the main shaft 102, unlike the first annular bearing 806. The first annular bearing 806 and the second annular bearing 816 supports multiple bearing balls 808. A second end of each of the extension members 708A, 708B, 708C connects to the second annular bearing 816 (Figure 8).

Multiple extension members 718A, 718B, 718C respectively connect the first annular bearing 806 to multiple weights 720A, 720B, 720C. Optionally, a plurality of pulleys 822 may be used to route the extension members 718A, 718B, 718C from the first annular bearing 806 to the weights 720A, 720B, 720C, and route the extension members 708A, 708B, 708C to the second annular bearing 816.

The transmission 900 includes flexible extension members 908A, 908B, 908C respectively connected at a first end to the pivot rings 136A, 136B, 136C. A second end of the extension members 908A, 908B, 908C connects to a synchronization member 912. Further each of the extension members 908A, 908B, 908C are slidingly engaged to a plurality of pulleys 916 (Figure 9) which are affixed to the hub shell 302. It is noted that the number and location of the each of the pulleys 916 (Figure 9) may be varied. For example, a different pulley configuration may be used to route the extension members 908A, 908B, 908C depending on the selected frame of the machine or vehicle that employs the transmission 900. Additionally, the pulleys 916 and extension members 908A, 908B, 908C may be located inside the hub shell 302.

The hub shell 302 of the transmission 900 is non-rotational. Further, the hub shell 302 includes a plurality of apertures (not shown) which are used to guide the extension members 908A, 908B, 908C to the synchronization member 912.

To be noted, according to the embodiment of the invention illustrated in Figures 9 and 10, the shifting assembly of the transmission 100 of Figure 2 may be eliminated, including the main shaft 102 (Figure 2), the tension member 202 (Figure 2), the extensions 162, 164 (Figure 2) and the shifting actuator (not shown).

Still referring to Figures 9 and 10, a method of operation for the transmission 900 is disclosed. Similar to the embodiment of the invention disclosed in Figure 1, an input torque causes a clockwise rotation of the drive sleeve 104, the first roller cage assembly 110, and the rotatable driving member 120. The rotatable driving member 120 engages the power adjusters 122A, 122B, 122 to rotate, and thereby drive the rotatable driven member 170. The rotation of the rotatable driven member 170 drives the second roller cage assembly 180 and produces an output torque.

In the transmission 900, the ratio of rotation between the rotatable driving member 120 and the rotatable driven member 170 is adjusted by the manipulation of the synchronization member 912. As the synchronization member 912 is outwardly directed from the hub shell 302, the extension members 908A, 908B, 908C respectively pivot the pivot rings 136A, 136B, 136C such that the axis of rotation of each of the power adjusters 122A, 122B, and 122C is similarly pivoted. The axis of rotation of each of the power adjusters 122A, 122B, 122C is modified such that the rotatable driving member 120 contacts a surface of power adjusters 122A, 122B, 122C further away from the axis of rotation of each of the power adjusters 122A, 122B, 122C. Conversely, the rotatable driven member 170 contacts the power adjusters 122A, 122B, 122C at a point on a

clutch 1210. The second rotatable driver 1206 is configured to engage the drive sleeve 104 upon the rotation of the second rotatable driver 1206 in a second direction, which is opposite to the activation direction of the first rotatable driver 1204. The second rotatable driver 1206 is fixedly attached to the drive sleeve 104.

Figure 13 schematically illustrates another alternative embodiment of the invention having a transmission 1300 that is configured to shift automatically. Three pulleys 1306, 1308, 1310 are respectively connected to the pivot rings 136A, 136B, and 136C. A cable 1312 is guided around the pulley 1306 and connects at a first end to the main shaft 102 and connects at a second end to an annular ring (not shown), similar to the annular ring 816 of Figure 8. Similarly, a cable 1314 is guided around the pulley 1308 and connects to the main shaft 102 at a first end and connects at a second end to the annular ring (not shown). Lastly, a cable 1316 is guided around the pulley 1310 and connects at a first end to the main shaft 102 and connects at a second end to the annular ring (not shown).

Figure 14 schematically illustrates the transmission 1300 of Figure 13 from a front end. A plurality of tension members 1404, 1406, 1408 interconnect each of the pivot rings 136A, 136B, and 136C. The tension member 1404 connects at a first end to the pivot ring 136A and connects at a second end opposite the first end to the pivot ring 136B. The tension member 1406 connects at a first end to the pivot ring 136B and connects at a second end opposite the first end at the pivot ring 136C. The tension member 1408 connects at a first end to the pivot ring 136A and connects at a second end opposite the first end at the pivot ring 136C.

Figure 15 schematically illustrates a housing 1500 for the transmission 1300 of Figures 13 and 14. The housing 1500 includes three hollow guide tubes 1504, 1506, and 1508. Each of the hollow guide tubes 1504, 1506, 1508 connect at a first end to a hub shell 1512 that holds the transmission 1300 and at a second end opposite the first end to a transmission wheel 1514. Three tension members 1516, 1518, 1520 are respectively disposed within the guide tubes 1504, 1506, 1508 and are connected at a first end to the transmission wheel 1514. A second end of the tension members 1516, 1518, 1520 opposite the transmission wheel 1514 are respectively connected with spherical weights 1526, 1528, 1530. In alternative embodiments of the invention, the weights 1526, 1528, 1530 may be adapted to other geometric shapes.

Multiple linkage members 1532, 1534, 1536, respectively extend from the weights 1526, 1528, 1530 to an annular member (not shown), such as the annular member 806 of

Figure 19 depicts a support member 1900 having a concave outer surface. The shape of the support member 1900 prevents the support member 1900 from wandering across the main shaft 102 while the transmission 100 is in use.

Figure 20 illustrates an alternative embodiment of the of the present invention. The first thrust bearing 1106 is rotatably disposed over the main shaft 102 and is positioned between the support member 154 and a first thrust washer 2006. The second thrust bearing 1108 is disposed over the main shaft 102 on a side of the support member 154 opposite the first thrust bearing 1106. The second thrust bearing 1108 is positioned between the support member 154 and a second thrust washer 2008. The second thrust washer 2008 is operably connected to a tension inducer 2018. The tension inducer 2018 provides a force that returns the support member 154 to its neutral position when the transmission 2000 is not shifting. Opposite the second thrust washer 2008, the tension inducer 2018 may be secured to the main shaft 102, the stationary support 152 (not shown), or other component of the transmission 2000.

A first end of a tension inducer 2016 contacts the first thrust washer 2006. The other end of the tension inducer 2016 may be secured to the main shaft 102, the stationary support 152 (Figure 2), or other component of the transmission 2000. Preferably, to minimize friction, a small amount of play is allowed between the first thrust bearing 1106, the second thrust bearing 1108, and the support member 154.

Figure 21 illustrates an alternative embodiment of the invention using the first thrust bearing 1106 (also shown in Figure 11) and the second thrust bearing 1108 (also shown in Figure 11). The first thrust bearing 1106 is rotatably disposed over the main shaft 102 and is positioned between the support member 154 and a first thrust washer 2106. The second thrust bearing 1108 is disposed over the main shaft 102 and positioned between the support member 154 and a second thrust washer 2108. Each of the pivot supports 134A, 134B, 134C have four extensions 2110, 2112 (Figure 24), 2114, 2116 (Figure 24) that are adapted to interface with the support ring 154. The extensions 2110, 2112, 2114, 2116 of the pivot supports 134A, 134B, 134C are adapted to direct the support member 154 such that it is constantly positioned underneath the power adjusters 122A, 122B, 122C during the operation of the transmission. The first thrust washer 2106 is positioned between the first thrust bearing 1106 and the extensions 2110, 2112, 2114, 2116 of the pivot supports 134A, 134B, 134C. Preferably, to minimize friction, a small amount of play is allowed between the first thrust bearing 1106, the second thrust bearing 1108, and the support

has a radius equal to or slightly larger than the radius of the swivel 2730. The swivel 2730 is of a cylindrical or spherical design allowing it to rotate in the groove 2760. The ends of the swivel 2730 are respectively connected to an angular support 2710A and an angular support 2710B. The angular support 2710A and the angular support 2710B are respectively connected, opposite the groove 2760, to the interconnecters 2720A, 2720B. The interconnectors 2720A, 2720B connect to the pivot supports 134A, 134B, 134C, thereby anchoring the pivot supports 134A, 134B, 134C to the stationary support 152 and also insuring that all the pivot supports 134A, 134B, 134C rotate in unison. The interconnecters 2720A and 2720B fit into the grooves 2122A (Figure 23) of the first pivot support part 2120 or the apertures 142, 144 (Figure 21) of the pivot supports 134A, 134B, 134C.

The interconnecters 2720A and 2720B are respectively attached, at an end opposite the angular supports 2710A and 2710B, to pivot members 2740A and 2740B. The pivot members 2740A and 2740B are respectively inserted into the apertures 142, 144 of each of the pivot supports 134A, 134B, 134C thereby providing a pivot for each of the pivot supports 134A, 134B, 134C.

In one embodiment of the invention, the main shaft 102 may be adapted to mate with the stationary support 152 in such a manner as to prevent the stationary support 152 from rotating about the main shaft 102. For example, in the embodiment of the invention disclosed in Figure 27, a flat edged aperture 2780 in the center of the stationary support 152 prevents the stationary support 152 from rotating. An exemplary main shaft 102 having an adapted outer diameter is shown in Figures 32 and 33. Further, the flat edged aperture 2780 enables the quick assembly of the stationary support 152 to the shaft 102. Alternatively, the stationary support 152 can be affixed to the main shaft 102 by traditional means.

Figures 30 and 31 illustrate an alternative embodiment of the stationary support 152 of Figures 27-29. The stationary support 152 has one leg 153. In this embodiment, the immobilizer 2702B (Figure 27) and the immobilizer 2702C (Figure 27) are adapted to be directly connected to the other pivot supports 134A, 134B, 134C in the transmission. Since the immobilizer 2702A is anchored to the main shaft 102, each of the power adjusters 122A, 122B, 122C are also anchored to the main shaft 102 through their connection to the immobilizer 2702A. Advantageously, the use of one only one leg 153 reduces manufacturing costs over those embodiments of the invention having multiple legs.

The transmission 3500 includes multiple identically configured cable assemblies, one for each of the power adjusters 122A, 122B. 122C. However, for purposes of simplicity of description, only one of the cable assemblies will be explained. The flexible cable 1316 is attached at a first end to the main shaft 102 (not shown). From the main shaft 102, the flexible cable 1316 travels around the pulley 1310, and continues to pulley 3520A, attached to one of the legs 153 of the stationary support 152. After wrapping around the pulley 3520A, the flexible cable 1316 passes through the aperture 3614 (Figure 36) and terminates by attaching to the second annular bearing 816. The second annular bearing 816 is stationary and does not rotate.

From a first end that is attached to the first annular bearing 806, the flexible cable 1532 passes through aperture 3624 and travels to a pulley 3522A. From the pulley 3522A, the cable 1532 passes through an aperture (not shown) in the hub shell 302 to the pulley 3524A.

In the embodiment of the invention shown in Figure 35, the first annular bearing 806 rotates with the hub shell 302. The rotation of the first annular bearing 806 is facilitated by ball bearings 808 that are situated between the first annular bearing 806 and the second annular bearing 816. From the pulley 3524A, a flexible cable 1532 may pass around one or more other pulleys (not shown) or continue directly to and attach to the weight 1526 (shown in Figure 15).

Figures 37 and 38 illustrate an alternative embodiment of the transmission 3700 including a coasting mechanism 3710. The coasting mechanism 3710 can be used in connection with bicycles, motorcycles, automobiles and machinery where disengaging the transmission is desired. The coasting mechanism 3710 is positioned between the hub driver 186 and the second roller cage assembly 180. When torque is applied to the rotatable driven member 170, the second roller cage assembly 180 responds by rotating in the same direction as the rotatable driven member 170. The rollers 112 roll up the shallow grooves of the rotatable driven member 170. The action of the rollers 112 causes the coasting mechanism 3710 to be directed toward the hub driver 186. The coasting mechanism 3710 does not rotate with the rotatable driven member 170 because two slots 3716A and 3716B in the coasting mechanism 3710 engage a clutch ring 3714. The clutch ring 3714 is frictionally attached to the main shaft 102 and has two prongs which extend into the two slots 3716A and 3716B of the coasting mechanism 3710. The coasting mechanism 3710

of the invention. The scope of the invention is indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

6. A transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable driven member rotatably and coaxially mounted with respect to the rotatable driving member;

a plurality of power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member and adapted to transmit power from the driving member to the driven member; and

a rotatable support member frictionally engaged to the plurality of power adjusters, so that the power adjusters each make three point frictional contact against the driving member, the driven member, and the power adjusters, and

a stationary support fixedly mounted, the stationary support anchoring the power adjusters to a non-moving component of the transmission to prevent orbiting of the power adjusters.

7. The transmission of Claim 6, further comprising a plurality of pivot supports, one pivot support for each of the power adjusters, the pivot supports defining an axis of rotation for each of the power adjusters.

8. The transmission of Claim 8, wherein the pivot supports are interconnected by a plurality of immobilizers that fix the spatial positioning of the pivot supports in relationship to each other.

9. The transmission of Claim 6, further comprising a hollow shaft and a shifting member, the shaft extending coaxially through the rotatable driving member and the rotatable driven member, the shifting member positioned in the hollow shaft, wherein the shifting member is configured to actuate an adjustment in an axis of rotation in each of the power adjusters.

10. The transmission of Claim 6, further comprising a shaft extending coaxially through the rotatable driving member and the rotatable driven member, wherein the support member is mounted coaxially over the shaft.

11. An automatic shifting transmission comprising:

18. A variable speed transmission comprising:

a drive sleeve rotatably and coaxially mounted;

a rotatable driving member rotatably and coaxially mounted over the drive sleeve;

a rotatable driven member rotatably and coaxially mounted over the drive sleeve;

a plurality of power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member and adapted to transmit power from the driving member to the driven member; and

a rotatable support member frictionally engaged to the plurality of power adjusters, so that the power adjusters make three point frictional contact against the driving member, the driven member, and the rotatable support member.

19. The transmission of Figure 18, further comprising:

a first one way rotatable driver fixedly and coaxially attached over the drive sleeve, the first one way rotatable driver configured to drive the transmission in a first rotational direction; and

a second one way rotatable driver fixedly and coaxially attached over the drive sleeve, the second one way rotatable driver configure to drive the transmission in a second rotational direction.

20. The transmission of Claim 18, further comprising a hollow shaft and a shifting member, the hollow shaft extending coaxially through the rotatable driving member and the rotatable driven member, the shifting member slidingly positioned within hollow shaft, the shifting member configured to actuate an adjustment in an axis of rotation in each of the power adjusters.

21. A transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable driven member rotatably and coaxially mounted with respect to the rotatable driving member;

a plurality of power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member, each of the power adjusters

28. The transmission of Claim 27, wherein the at least one tension member and the at least one flexible tension member guide are attached to the pivot supports on substantially opposite sides of the pivot supports.

29. The transmission of Claim 27, wherein the at least one tension member and the at least one flexible tension member guide are attached to the pivot supports at about 160 to 200 degrees from each other.

30. The transmission of Claim 2829, wherein at least two tension members are attached to each pivot support, the tension members tilting the pivot supports in a first direction.

31. The transmission of Claim 25, wherein the at least one immobilizer is attached to a hubshell encasing the rotatable driven member and the rotatable driving member.

32. The transmission of Claim 25, further comprising at least one flexible tension member operably connected to the pivot supports, the at least one flexible tension member configured to adjust the axis of rotation of each of the power adjusters.

33. The transmission of Claim 32, further comprising a plurality of flexible tension member guides respectively attached to the plurality of pivot supports, the at least one flexible tension member supported by each of the flexible tension member guides.

34. The transmission of Claim 33, further comprising a plurality of tension members that are fixedly attached to the pivot supports, the tension members adapted to modify the axis of rotation for each of the power adjusters.

35. The transmission of Claim 21, further comprising at least one outwardly extendible weight coupled to the plurality of power adjusters, the at least one weight adapted to actuate a change in an axis of rotation of the plurality of power adjusters.

40. The transmission of Claim 39, wherein at least one flexible tension member guide is attached to each pivot support, the flexible tension member guide adapted to tilt the pivot supports in a first direction.

41. The transmission of Claim 39, further comprising at least one annular bearing connected to the at least one flexible tension member, the annular bearing configured to adjust the axis of rotation of each of the power adjusters.

42. The transmission of Claim 37, further comprising at least one flexible tension member fixedly attached each pivot support, the flexible tension member adapted to adjust the axis of rotation of the plurality of power adjusters.

43. The transmission of Claim 42, further comprising at least one flexible tension member guide, the flexible member guide supporting the flexible tension member.

44. The transmission of Claim 37, further comprising at least one weight, the weight operably connected to the pivot supports, the at least one weight adapted to automatically vary the speed of the transmission.

45. A transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable driven member rotatably and coaxially mounted with respect to the rotatable driving member;

a rotatable support member;

a plurality of power adjusters frictionally interposed between the rotatable driving member, the rotatable driven member, and the rotatable support member; and

means for maintaining the support member in frictional contact with the plurality of power adjusters.

46. A transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable support member rotatably mounted with respect to the rotatable driving member;

a plurality of power adjusters frictionally interposed between the rotatable driving member, the rotatable driven member, and the support member, each power adjuster centrally positioned within one of the pivot supports; and

means for engaging and disengaging the transmission.

49. A continuously variable transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable driven member rotatably and coaxially mounted with respect to the rotatable driving member;

three or more rotatably mounted power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member;

means for altering the axes of rotation of the three or more power adjusters,

control means for equally altering the axes of rotation of all of the three or more power adjusters;

a support member rotatably mounted so that the three or more power adjusters make three point contact with the support member, the rotatable driving member, and the rotatable driven member;

a rotatable input driver rotatably and coaxially mounted with respect to the rotatable driving member;

a first plurality of three or more rollers positioned on the driving side of the rotatable driving member, the first plurality of three or more rollers enabling the force applied to the power adjusters to be increased via the rotatable driving member as torque is increased;

a rotatable output driver rotatably mounted;

a second plurality of three or more rollers positioned on the driven side of the rotatable driven member, the second plurality of three or more rollers enabling the force applied to the power adjusters to be increased via the rotatable driven member as torque is increased; and

a stationary support rigidly fixedly attached to an immovable surface, the stationary support preventing the orbiting of the three or more power adjusters.

a stationary support rigidly attached to an non-rotatable component of the transmission, the stationary support anchoring the three or more power adjusters;

three or more pivot supports, one pivot support for each power adjuster, the pivot supports varying, upon shifting the transmission, the axis of rotation for the power adjusters;

three or more interconnecters, one interconnecter for each pivot support, each interconnecter contacting two pivot supports, the interconnectors fixing the spatial relationship of the pivot supports in relationship to each other;

at least one flexible tension member operably connected to the pivot supports; and

three or more flexible tension member guides, at least one flexible tension member guide attached to each pivot support, the flexible tension member guides tilting the pivot supports in a first direction.

55. The transmission of Claim 53, wherein each of the pivot supports have at least four apertures, two of the apertures defining an axis of rotation for the power adjusters, two of the apertures defining an axis of rotation for the power support.

56. A continuously variable transmission comprising:

a rotatable driving member rotatably and coaxially mounted;

a rotatable driven member rotatably and coaxially mounted with respect to the rotatable driving member;

three or more rotatably mounted power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member,

control means for equally and simultaneously altering, upon shifting, the axes of rotation of each of the power adjusters;

a support member rotatably mounted so that the three or more power adjusters make three point contact with the support member, the rotatable driving member, and the rotatable driven member;

a rotatable input driver rotatably and coaxially mounted with respect to the rotatable driving member;

a first plurality of three or more rollers positioned on the driving side of the rotatable driving member, the first plurality of three or more rollers compressing the

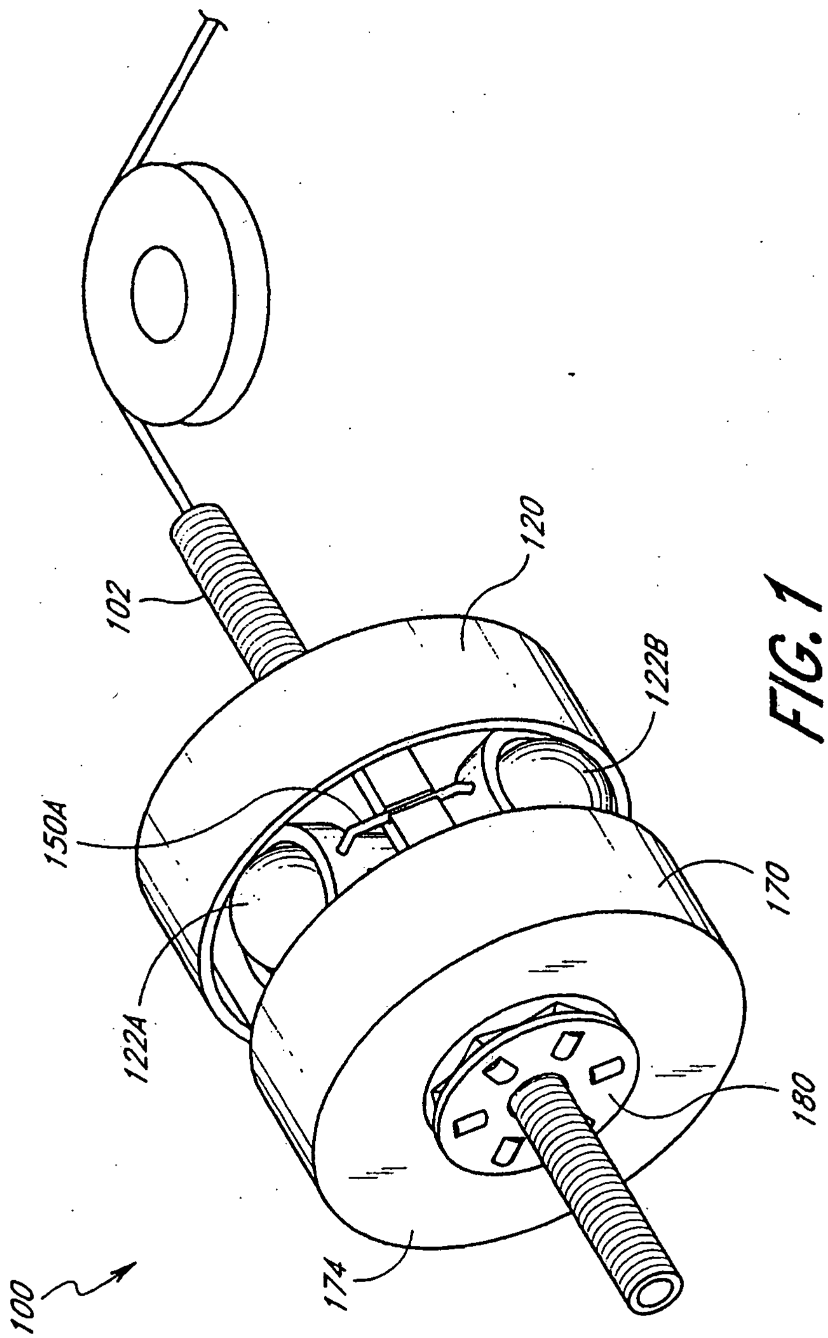

FIG. 1

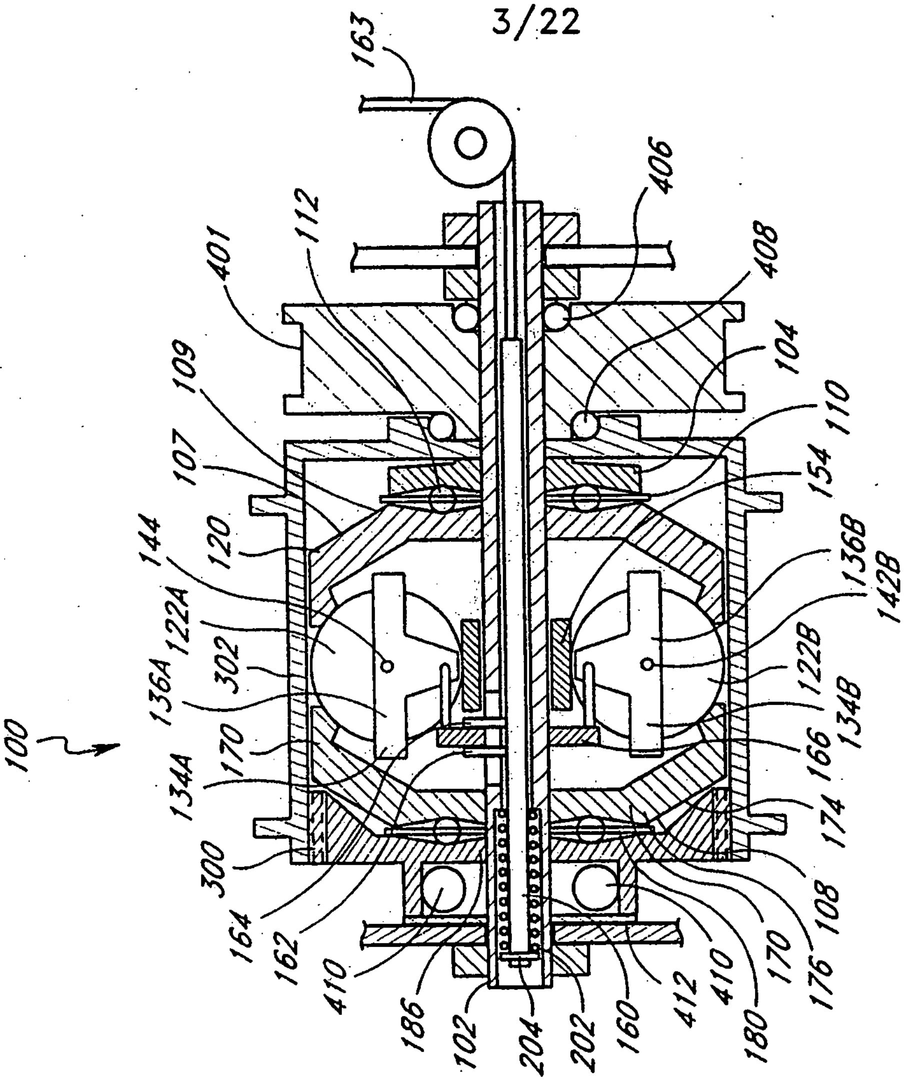
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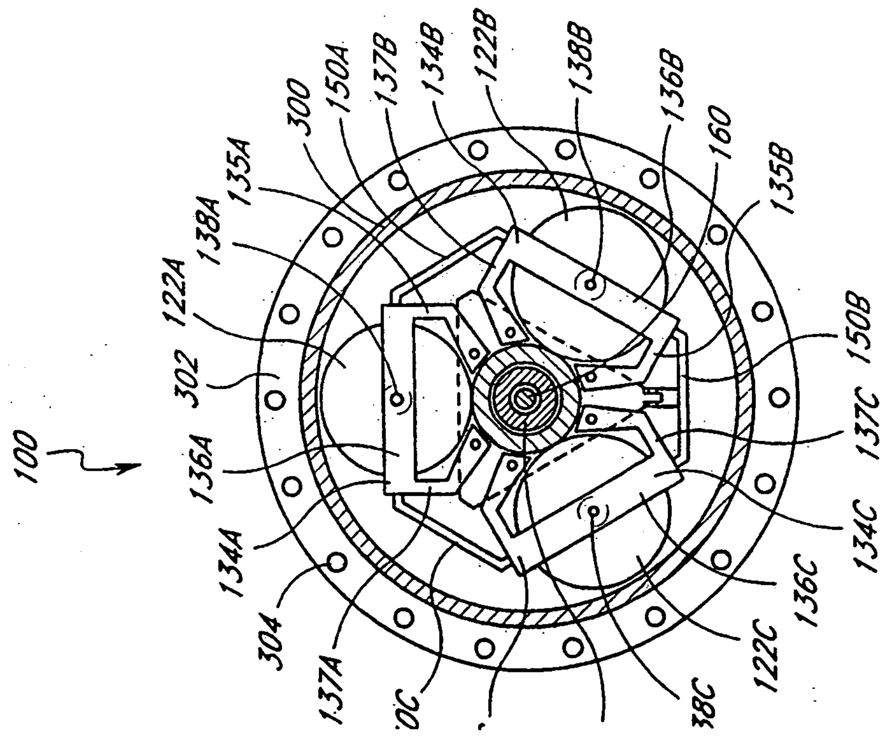
FIG.4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136C
122C
137A

FIG.3

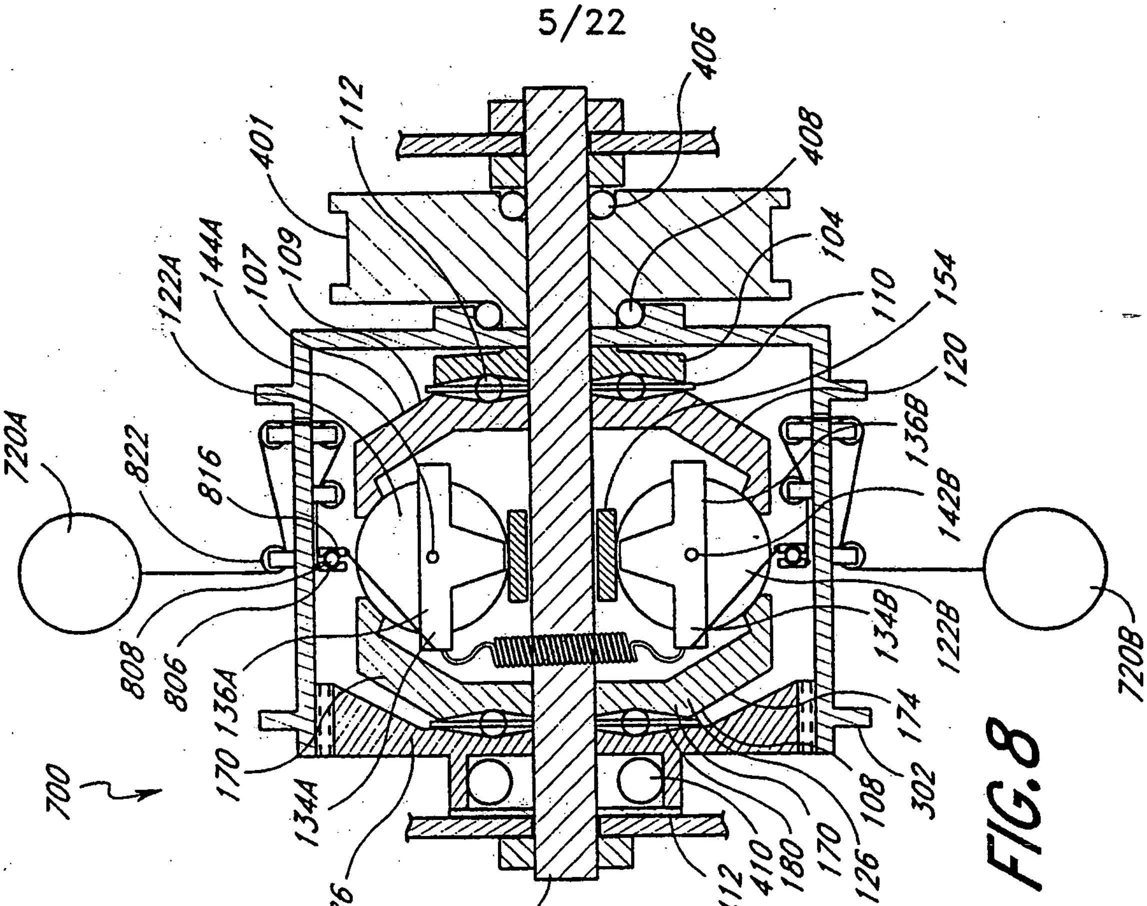
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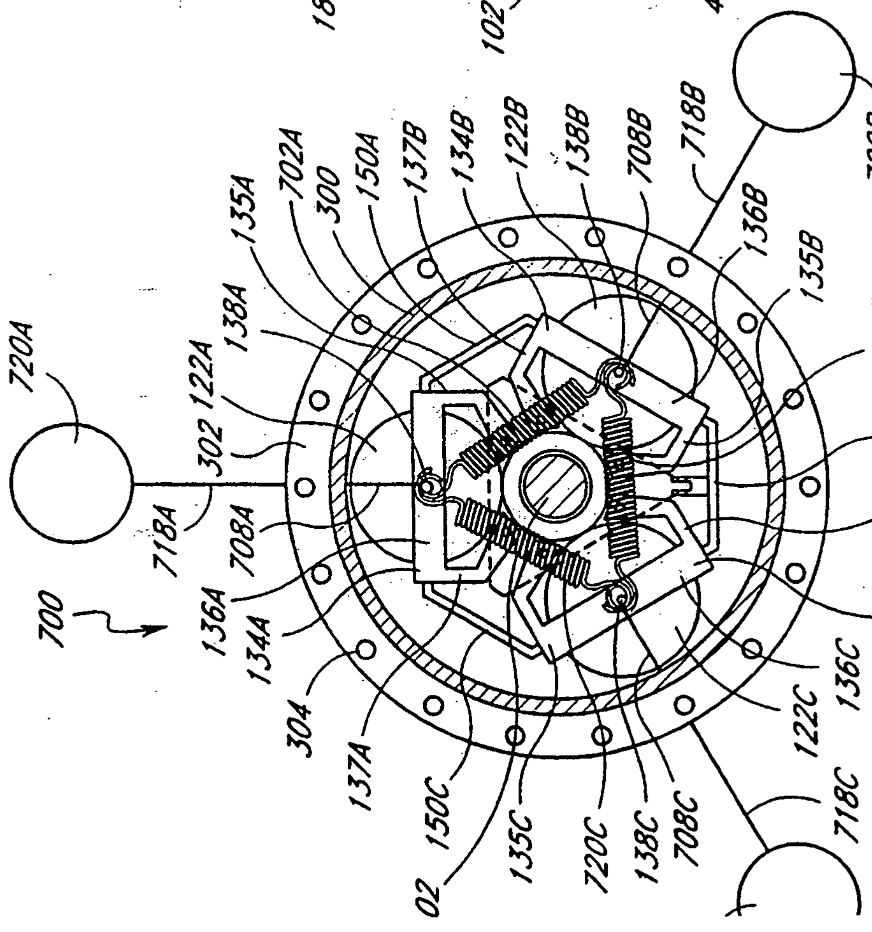
FIG.8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134C
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718C
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FIG.7

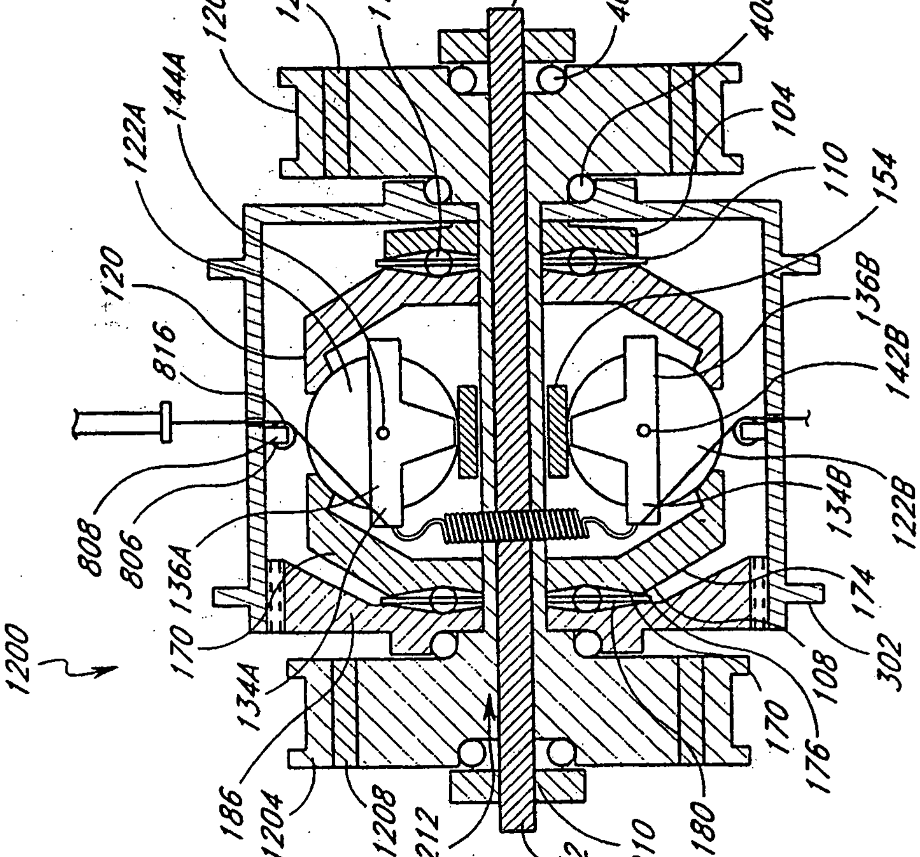
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FIG. 12

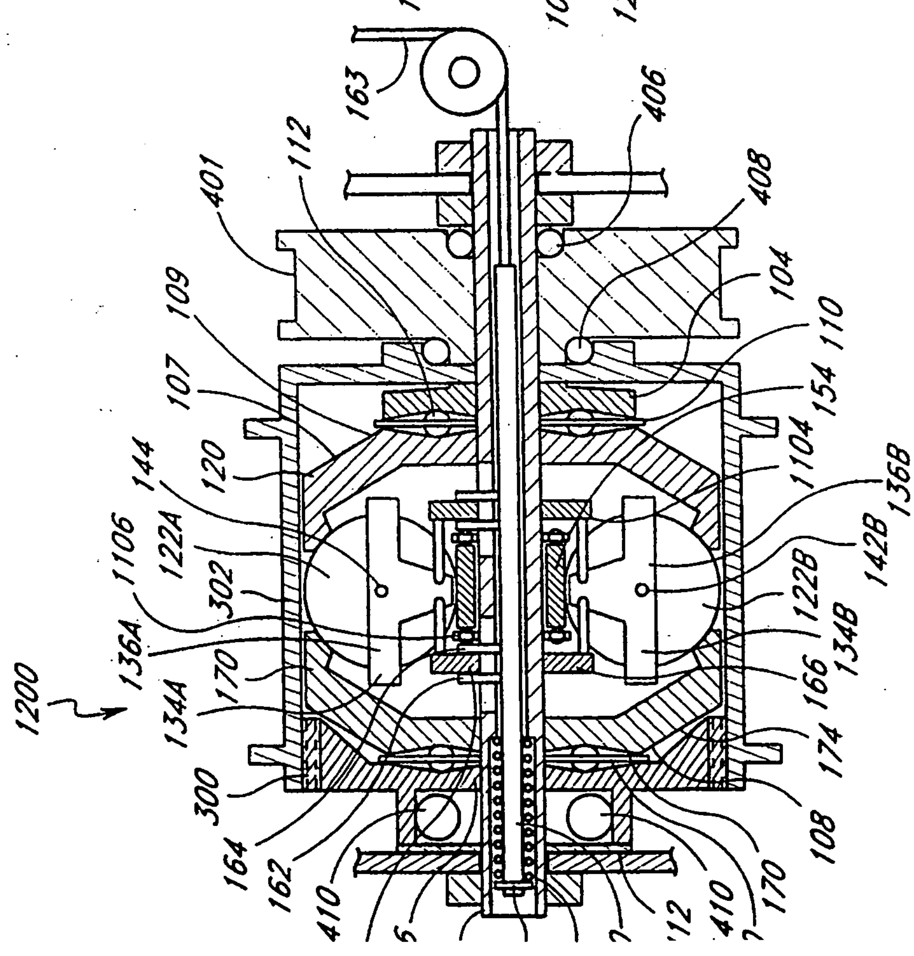
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FIG. 11

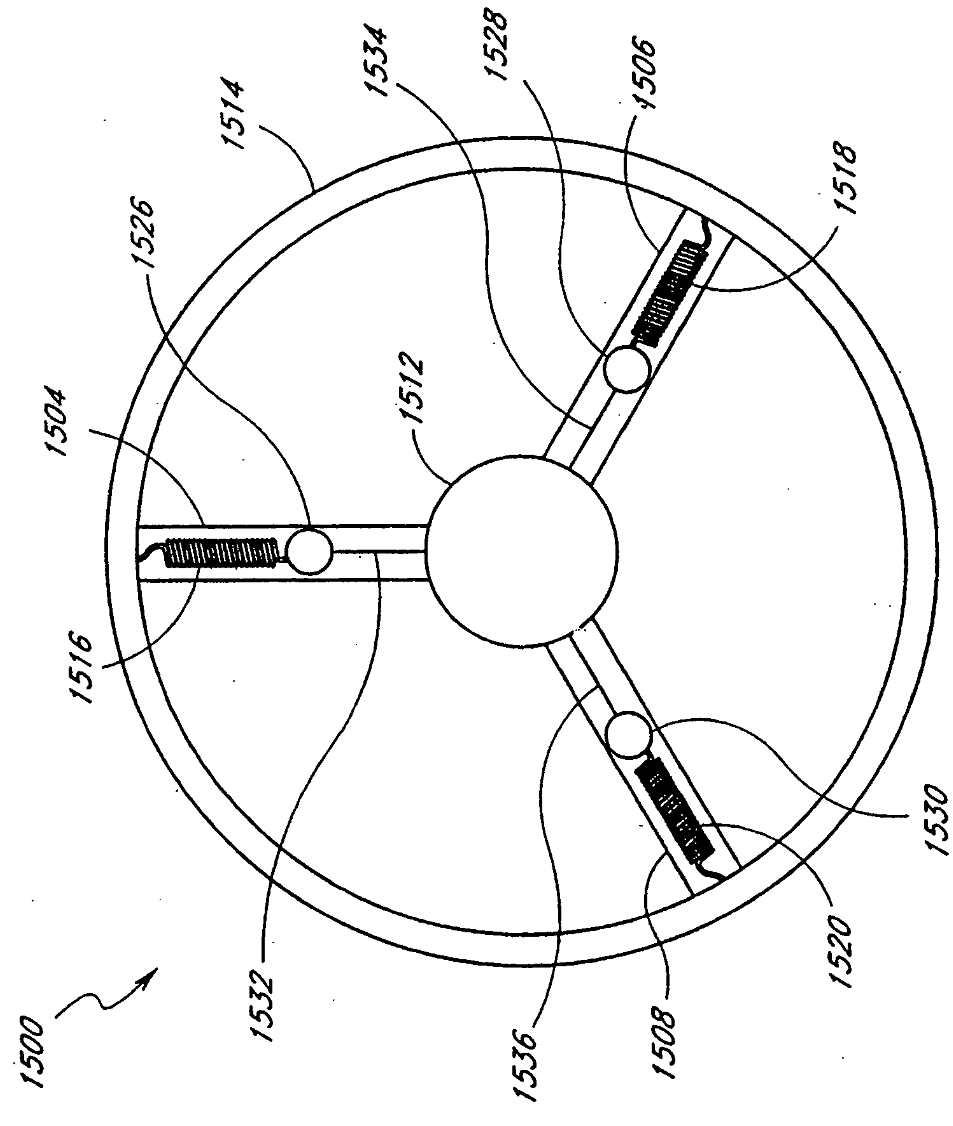
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FIG. 15

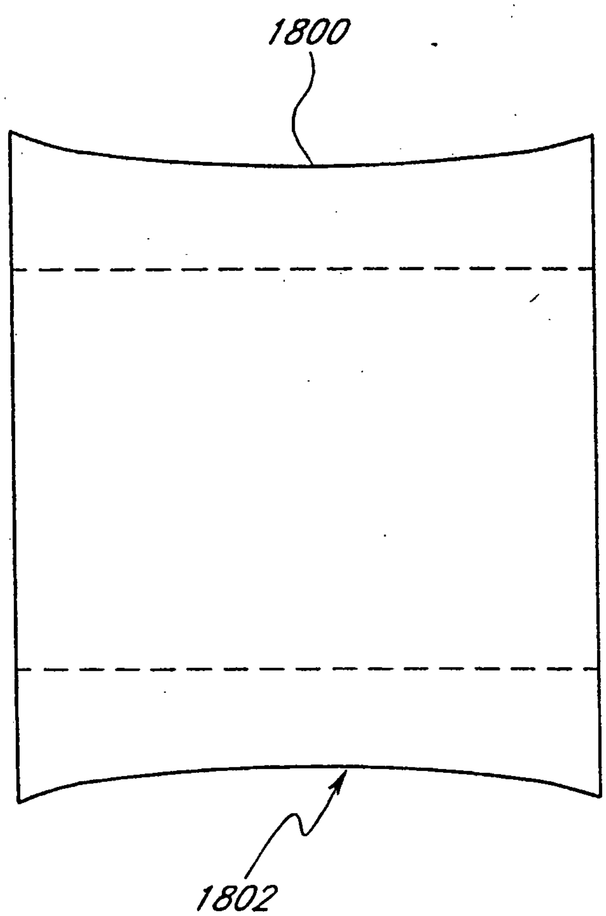

FIG. 18

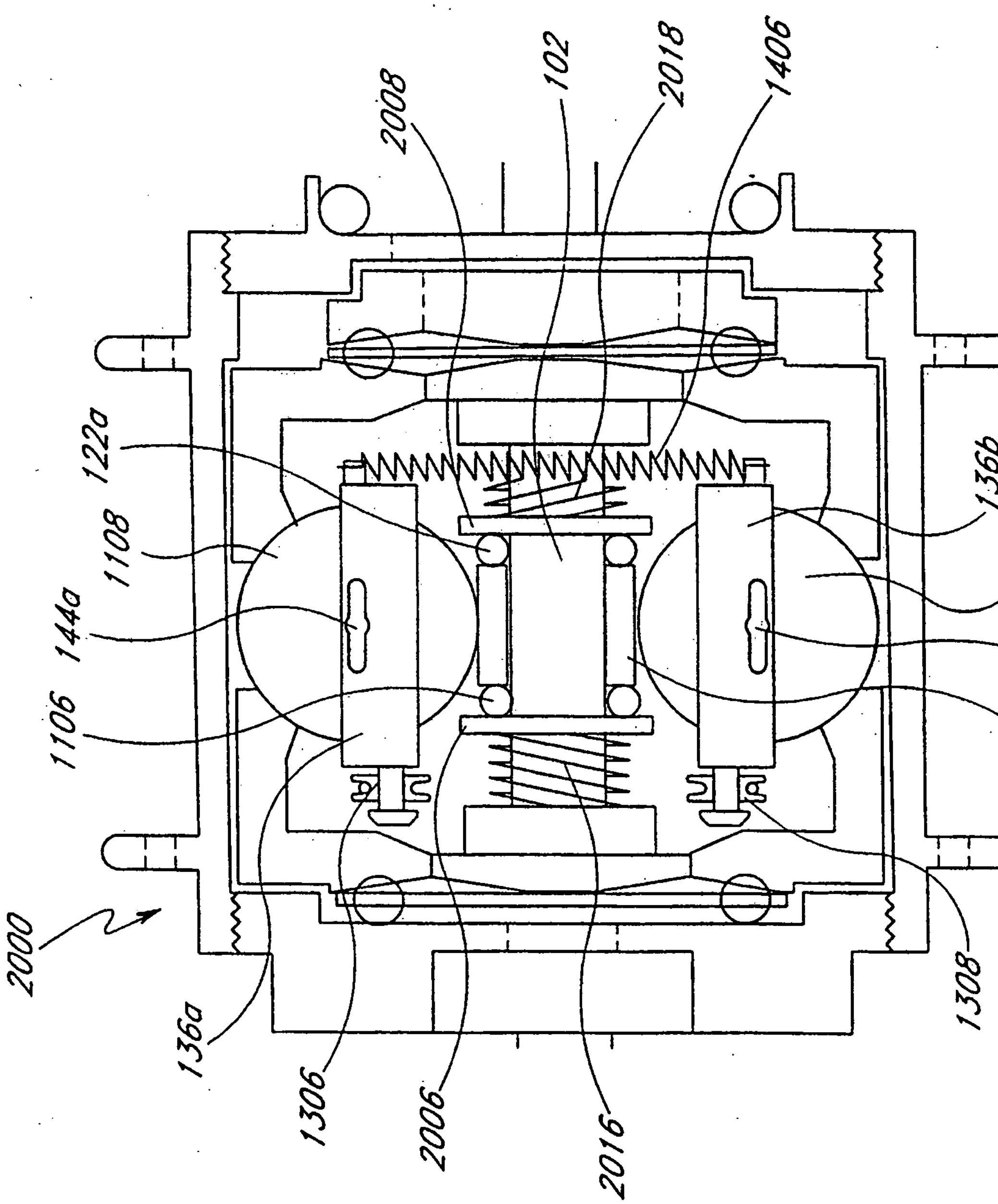
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FIG.20

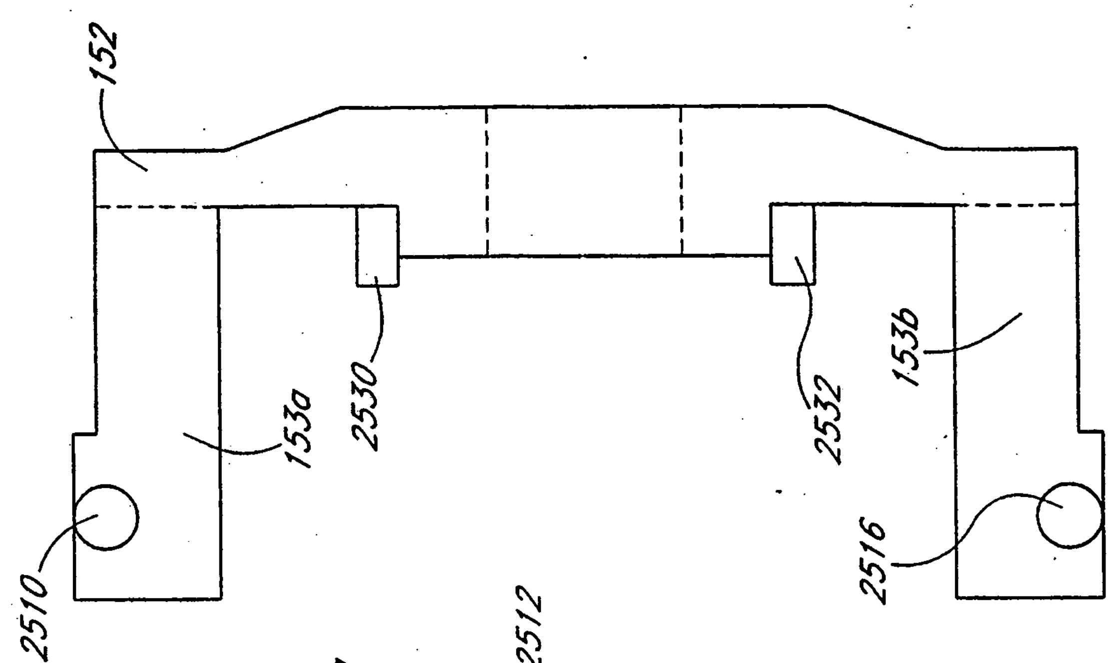
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FIG.26

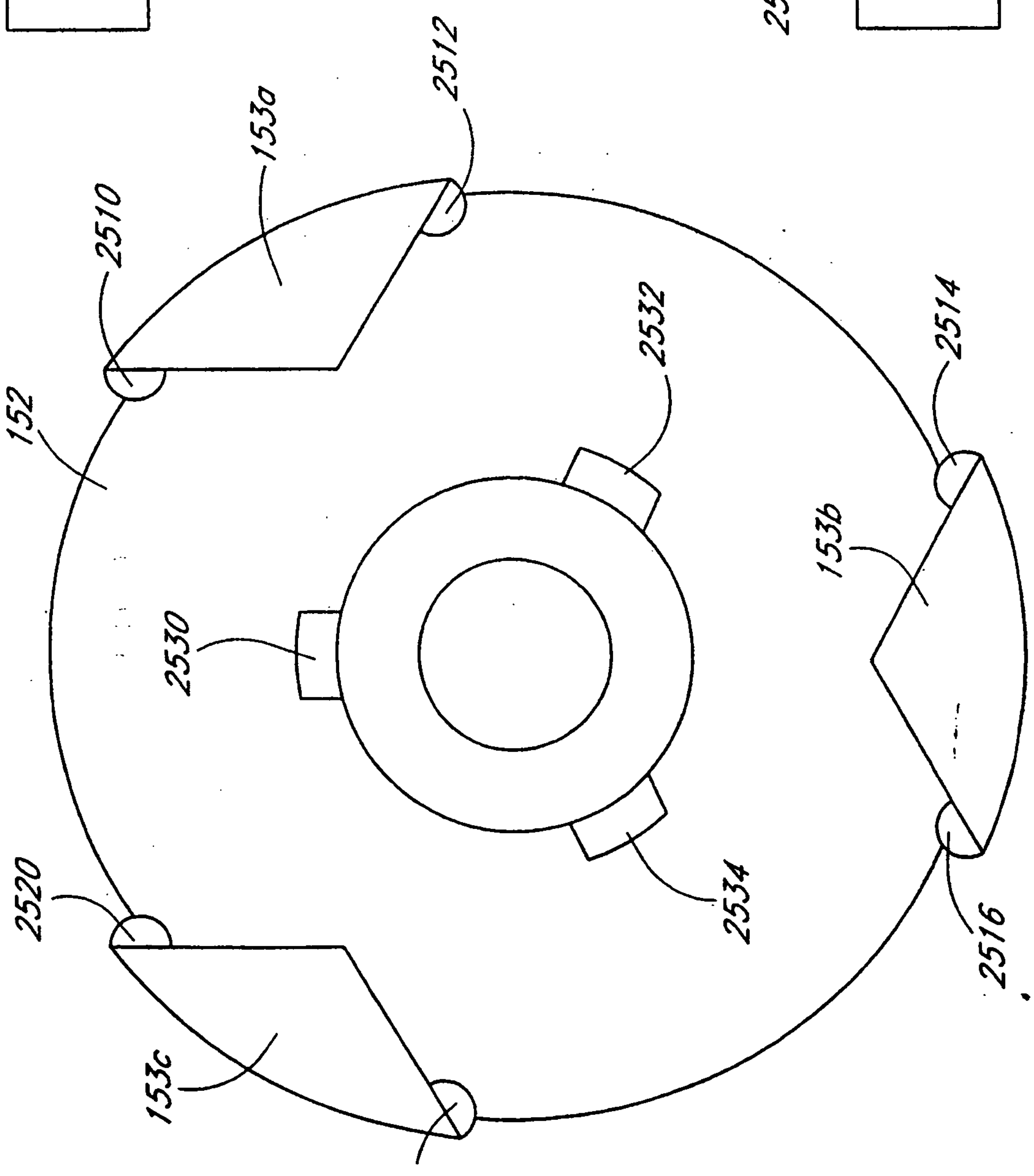
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FIG.25

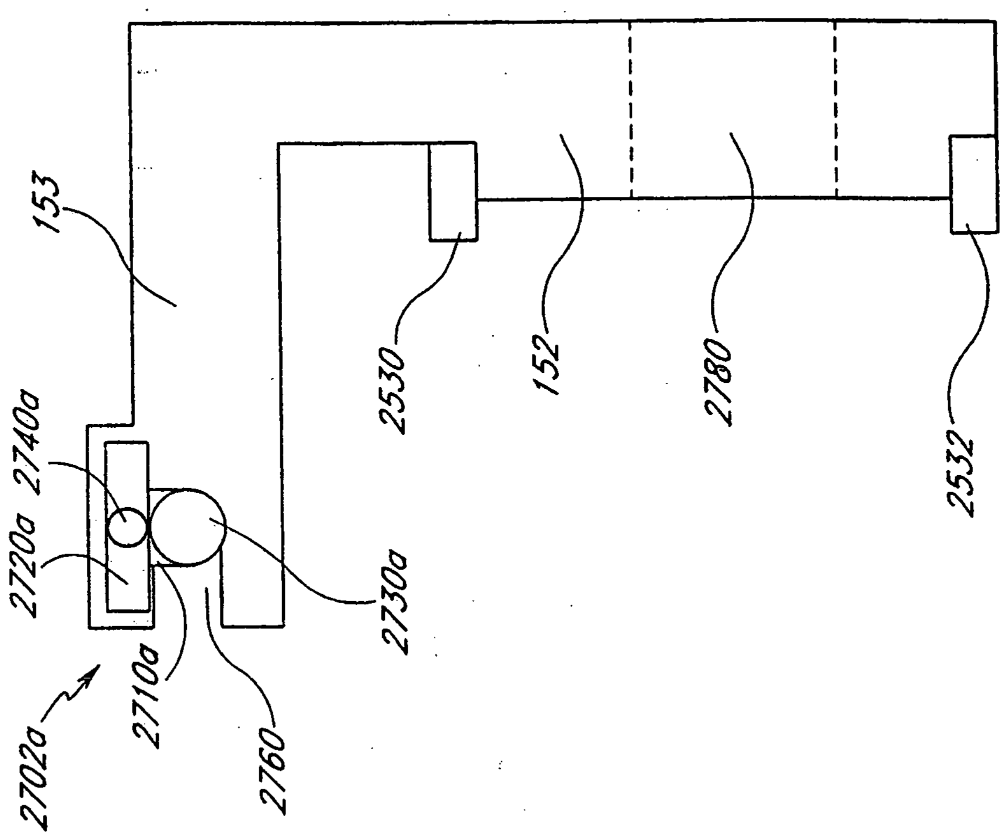
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FIG.31

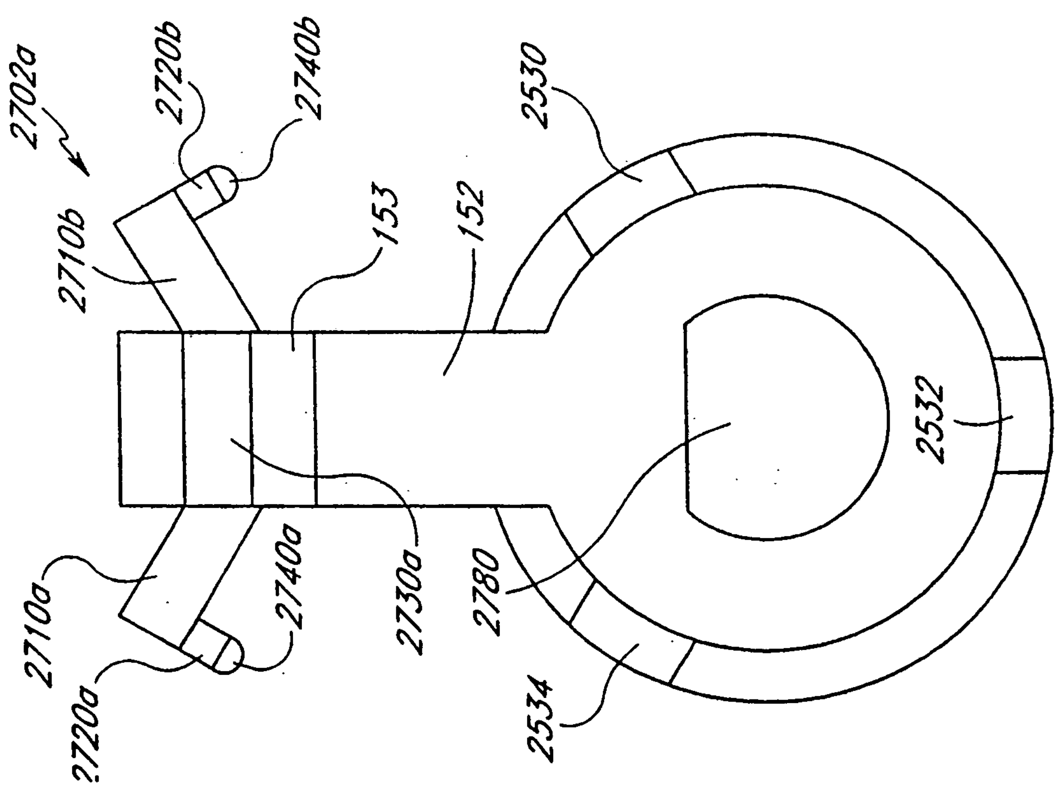
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FIG.30

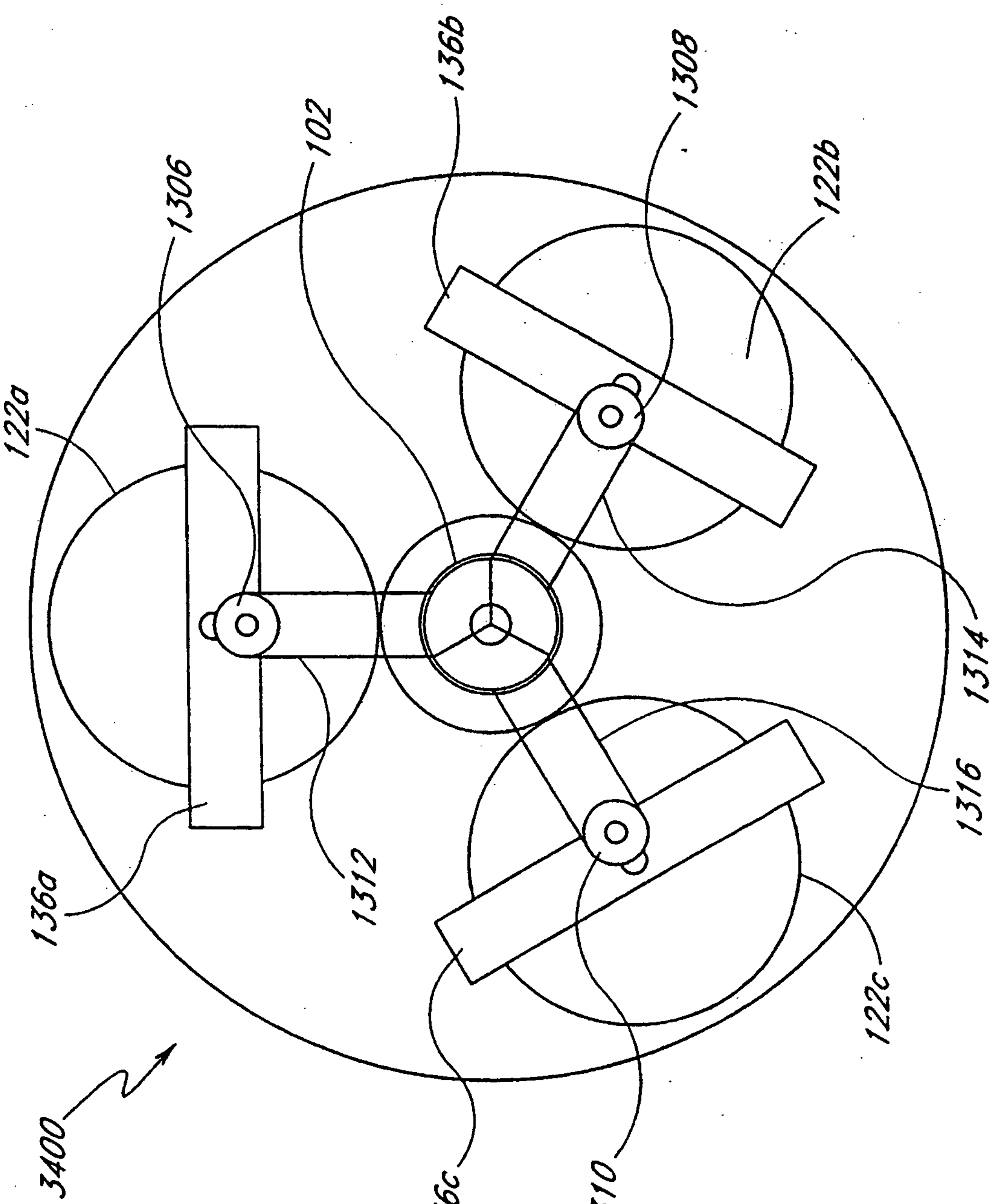
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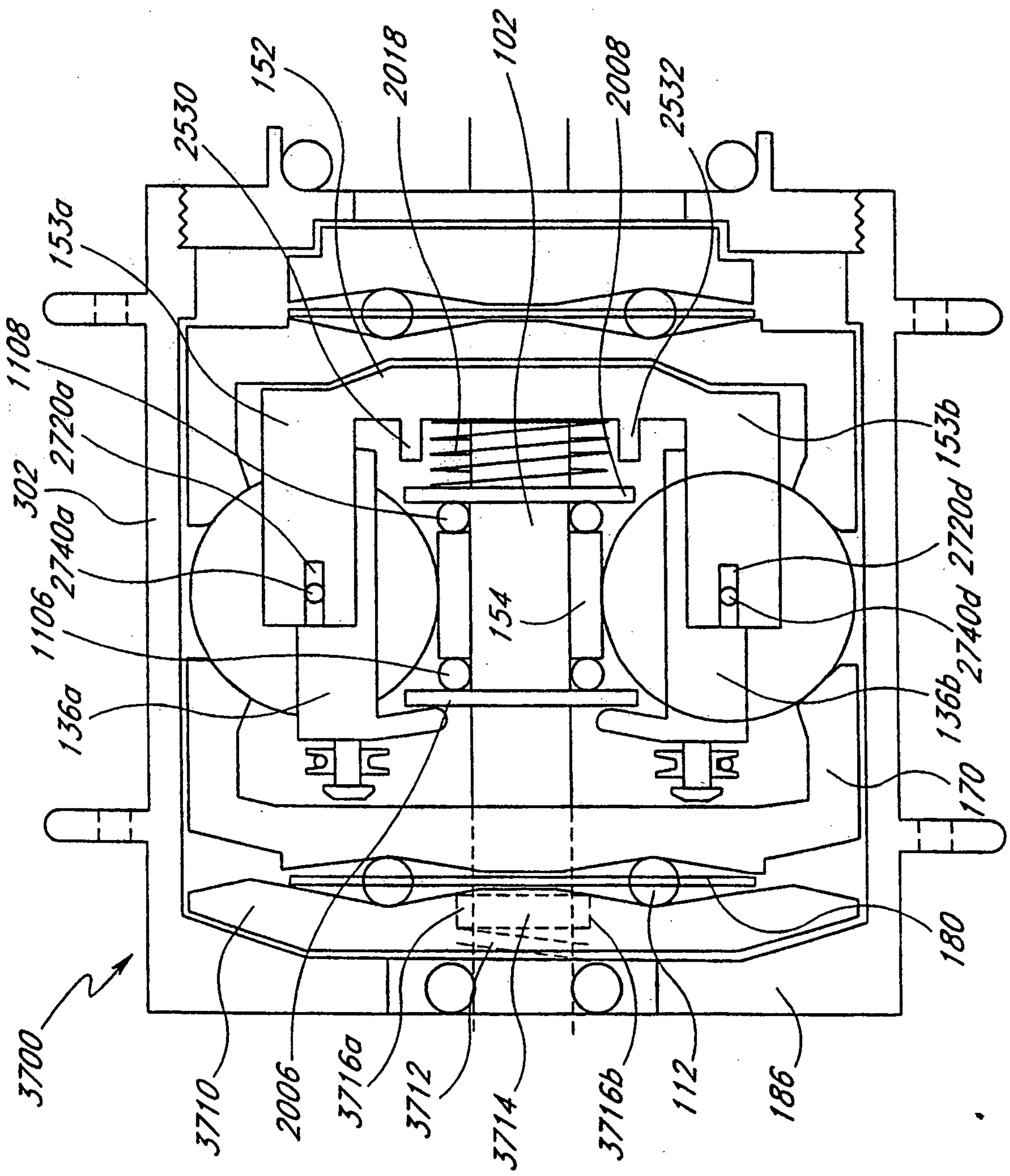
FIG.34



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186

FIG.37

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/22432

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :F16H 15/26
US CL :476/36, 38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 476/36, 38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -------- Y	US 5,236,403 A (Schievelbusch) 17 August 1993 (17.08.93), figures 1-4.	1-4,6,7,9, 10,18,19, 21,22,24-29,31,32, 36,37,41-43,45,47-53 -------------- 11-17,35, 38,44

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search
25 JANUARY 1999

Date of mailing of the international search report
22 FEB 1999

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/22432

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,318,486 A (Lutz) 07 June 1994 (07.06.94), figures 1-3.	1-4,6,7,9,10,18,19,21,22,24-29,31,32,36,37,41-43,45,47-53 --- 11-17,35,38,44
Y	US 3,237,468 A (Schottler) 01 March 1966 (01.03.66), figure 9.	11-17,35,38,44